a traffic, of which you will find no record in commercial literature—the training of teachers and exchanging with each other—a commerce that is indicated in university and scientific publications. This is a kind of intellectual in-and-in breeding. Among animals and plants this is only practised where the intention is to establish a fixed type that will not change but remain stable. Hence it is that your type of teacher and teaching is so fixed and to a certain degree inflexible. A teacher instructs as he was himself taught to do—taught that it was the one and only way. If he departs therefrom to the extent of substituting direction for instruction he feels as though he was a discordant note, and has somehow done something not just right.

This is not intended so much as a criticism as pointing out the fact that it simplifies correction. The matter is one that the pedagogue can change and correct, because the old method has become antiquated. The time was when the pedagogue could and did decide the sort of training necessary, and perhaps it was, at that time, best that he did so, but times have changed since then. Up to not so many years ago when instruction was even more functional than now it was hard to find a university-trained man in the employ of industrial firms or corporations. Now there are many. There must, however, be still further modifications to meet the still more exacting demands at present made upon university-trained men. The business man succeeds by being the first to see a demand as well as the first to supply it. If you will allow me to put it in a homely way, the pedagogue must get down from his antiquated pedestal that is badly affected both by dry rot and Lyctidæ and get on to another, more substantial, of concrete and steel perhaps.

You can not suppose, for a moment, that we can carry on investigations that, ten years ago, we would not have dared to touch, with men trained just as they were ten or twenty years ago. This is far from being a personal matter. It is our irresistible, progressive civilization, the pride of every American, that calls for improvement, and it must come. Slowly, perhaps, but surely.

It has not been my aim in this paper to unduly criticize the progressive instructor, or the institution that is doing its best to break away from the old régime, but to encourage and if possible aid both in their laudable efforts.

If I have been able to put into the hands of those who are to train our entomologists for us in future facts or arguments that will aid them to push for a more rational, natural and therefore easier, though none the less thorough and severe, university training, I shall have certainly accomplished all that was intended.

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ON THE IMPROVEMENT OF MEDICAL TEACHING[1]

The watchword of the present is conservation. Especially in the industrial world it has been shown that great improvement is possible by the elimination of needless waste of time and energy. Though not yet so clearly recognized, this is equally true in the field of education. Teachers, especially those in the higher institutions of learning, are notoriously neglectful of the principles and technique of their profession. Unquestionably this results in great losses due to inefficient methods of teaching. These losses, in medical education, may be conservatively estimated at twenty to twenty-five per cent. In other words, the adoption of more efficient methods of teaching would probably enable

[1] Read at the twenty-second annual meeting of the Association of American Medical Colleges, Chicago, February 28, 1912.

us to gain the equivalent of a whole year within the time now devoted to the four years' curriculum. Is not the possibility of such a tremendous saving well worth our serious consideration?

At the outset, it should be clearly understood that *uniform* methods of teaching are neither necessary nor desirable. The methods in detail must be determined by the individual teacher to meet best the varying local conditions. But equally true is the important fact that all efficient methods of teaching must be based upon well-known and well-established principles of pedagogy. Efficient teaching requires three essential conditions: (1) Complete mastery of the subject-matter on the part of the teacher; (2) a clear notion of the aim of the teaching, and (3) well-chosen methods of accomplishing the aim. The first and most essential condition, that the teacher must be a master of his subject, is everywhere clearly recognized, and will not be discussed in the present paper. The second and third conditions are those oftenest overlooked, and it is therefore necessary to emphasize certain fundamental principles of aim and methods, the neglect of which is largely responsible for inefficient teaching.

In the first place, let us therefore consider the aim of medical education. In this all will probably agree that the *primary* aim of medical education should be to train efficient practitioners.[2] And it may furthermore be taken for granted that an efficient practitioner is one who is able to observe accurately, to think clearly and to act wisely in his medical practise.

Keeping in view this primary aim and ultimate purpose of medical education, to train efficient practitioners, we may next consider the methods, the ways and means, whereby this aim is to be accomplished. If the end is to be reached most directly, if the student is to be trained most economically for the greatest efficiency, it is evident that the instruction must be adapted to his nature and learning capacity. How shall this be done? Let us see whether there is any rational principle to guide us in adapting our methods to the nature of the student. Upon this question an important light is thrown by the history of education.

A century ago, practically all teaching was based upon the doctrine of authority. It was the function of the teacher to *tell* the student what he should know and do. It was the duty of the student to be a passive recipient, to follow faithfully the precepts of the teacher. This doctrine of authority, however, was found inefficient and has long since been abandoned in rational education. It is now generally recognized that all education really worth while is based upon *self-activity*. This principle, advanced by Froebel, is now so thoroughly established in education that it may almost be taken as self-evident. Self-activity is the keynote of modern pedagogy. And yet, while recognized in theory, this fundamental principle is often almost totally neglected in practise. In the light of this principle of education by self-activity let us review briefly certain phases of methods in medical teaching.

In developing the self-activity of the student, it is evident that the methods first of all must arouse his interest and attention. Interest we know to be most intense in things which satisfy conscious needs. Now the medical student wants above all to be a good practitioner. If he knows that a certain thing will help him to accomplish this, he is intensely interested, and will exert an active effort to secure it. "The mind interprets impressions from without, not according to their intrinsic nature, but accordingly to their relation to the needs of the organism" (Bagley). Common sense and good pedagogy therefore agree that in teaching any subject in the medical curriculum, the teacher should make sure that the student realizes its bearing upon his later work.

Some may conclude from the foregoing that, since time is limited, only the so-called

[2] In addition to the education of practitioners, the medical school has other important functions, such as the advancement of medical science through original investigation, but these are not within the scope of the present paper.

"practical" facts, those that are of obvious utility in the practise of medicine, should be taught, and that no time should be wasted on "theoretical" aspects. While this argument may appear plausible at first glance, its fallacy is apparent on closer examination. In the first place, it is impossible in any given subject to select out only those facts which may later be needed. Moreover, even if such facts could be selected, it would be impossible to teach them as bare, empirical facts, in such a way that the student could understand, remember and utilize them, without a comprehension of the science of which they form a part. The "theoretical," as Bagley states,

contributes to the coherence of the various facts and principles as *knowledge*. Its value can not be disputed, for any attempt to "cut out" the "impractical" parts invariably results in the inefficient functioning of the remainder. Short courses that give only the essentials, fifth-rate colleges and normal schools that educate you while you wait, are sufficiently damned by their own products.

There is, it must be acknowledged, some truth in both the "practical" and the "theoretical" points of view. The best methods of teaching will, therefore, utilize both. While each subject should be taught from the theoretical, scientific point of view, at the same time its practical application should be kept constantly in mind. In selecting material to develop the essential principles, those facts should be chosen which will also probably be of greatest intrinsic value for later work. Anatomy, for example, should be taught, not as a mass of empirical facts, but as a special branch of biological science. But in selecting from the huge mass of available data the facts necessary to illustrate the science of anatomy, so far as possible those facts should be chosen that are also of direct, intrinsic value in physiology, pathology and clinical medicine.

If this plan were consistently followed out, and everything excluded excepting facts, especially those of intrinsic value, necessary to develop a scientific basis, a "working-knowledge," for each branch of study, the amount of subject-matter presented in each could be greatly reduced. We all recognize that the curriculum is now overloaded. It is impossible to teach so much and teach it well. "What men need" (according to Huxley) "is as much knowledge as they can assimilate and organize into a train for action."

To develop in accordance with the foregoing plan the most effective methods of teaching, it is evident that each teacher must understand the curriculum as a whole. The laboratory man must be familiar with the clinical work. But this is not all. Since good teaching must take into account that which has gone before as well as that which is to follow, it is equally evident that the clinical man must be familiar with laboratory subjects and methods. We can not expect the best results in medical education until there is a better understanding and more cooperation between teachers of the various subjects all along the line. As medicine progresses, all phases appear more clearly as varied manifestations of the same underlying biological science, and only when this is realized will the clinical and laboratory work be more closely knitted together.

We have seen that to interest the student and arouse him to self-activity, he should be made to realize that each subject contributes an essential part in training him for the desired end. We may next inquire as to *how* he must be self-active. Since efficiency in practise consists in accurate observation and reasoning, resulting in wise action in dealing with medical problems, his training should develop self-activity in these very lines. He must observe, think and act for himself. For this purpose almost ideal facilities exist in our laboratories and clinics. Unfortunately, however, we are far from utilizing these facilities to their fullest extent. Our methods fail to make the student self-active, especially in observation and reasoning.

First we may consider observation. This can be cultivated only by actual observation of medical phenomena on the part of the student. It is, however, a surprising fact that in many laboratories and clinics there is no opportunity for the student to make an *orig-*

inal observation. Why? Simply because through a pernicious lecture system he has already been told all about what he is to see, before he has ever had a chance to observe it for himself.

It is furthermore a fundamental law of learning (technically the doctrine of apperception) that we can not comprehend new facts except upon the basis and in terms of previous concrete experience. Hence the dictum: "In teaching, always proceed from the concrete to the abstract; from the particulars to the general; from the known to the unknown." It is therefore evident that to give lectures preceding practical objective study not only prevents the exercise of original observation but also inverts the normal procedure in the process of learning.

Much time and energy is sometimes thus wasted in trying to teach by lectures what would be quickly and easily comprehended *after* the fundamental data had been acquired by objective study. In some schools, for example, the junior year is largely given over to lectures and other didactic work which is supposed to prepare the students for the actual clinical work, the latter being chiefly concentrated in the senior year. This, it seems to me, is a fundamental mistake. If there were only one alternative, it would be better to reverse this order, giving the clinics first, and the lectures later. In actual practise, however, they are best intermingled and closely correlated, care being taken always to provide the objective basis before the more abstract generalizations are considered.

Even when the practical work is placed first, however, it by no means follows that adequate training in observation will result. In both laboratories and clinics it is a common practise as a preliminary step to *tell* the student (either orally or by printed guides) what he is to see. The student thus is not required, and indeed has no opportunity, to observe for himself. Practically all there is left for him to do is to verify what he has already been told. However valuable this may be, it does *not* develop power of original observation. It is, of course, desirable to precede all practical work with a brief introduction which will enable the student to proceed intelligently with his work. Such an introduction, however, should be merely for the purpose of explaining technical procedure and of raising questions the answer to which the student should seek by original observation.

The ideal plan is thus for the student to work out everything for himself by the method of discovery. This applies not only to the original observations, but also to the later process of reasoning, whereby we proceed from particular data to general conclusions, and thence to rational action. The method of self-activity may therefore be expressed in a negative way by the following practical rules: Never tell a student anything he can observe for himself; never draw a conclusion or solve a problem which he can be led to reason out for himself; and never do anything for him that he can do for himself.

Unfortunately, however, there are limitations to the application of this method. It is difficult to apply successfully, requiring skill and experienced judgment on the part of the teacher. Lack of time would moreover prevent the student from repeating the history of the race by the method of discovery. But though difficult and slow at first, by working out for himself at least the fundamental data, a solid basis is laid which makes possible more rapid progress later. Time lost at the beginning is thus time gained in the end. We should therefore insist that *so far as practicable* this ideal method be applied for the purpose of training the student to self-activity, in developing his ability in observation, reasoning and action.

As supplementary to the foregoing, it is usually necessary to adopt easier though less effective methods of instruction. Thus where necessary data can not be secured by original observation, they may be supplied by the usual type of laboratory or clinical demonstrations, which the student can verify. Next in value below this as a means of imparting knowledge comes the informal lecture or recitation, illustrated by demonstrations, models, pictures, etc. Next comes the

text-book, and lowest of all in the scale is the formal lecture. Curiously enough, the lecture is also the *easiest* method, by which *apparently* the greatest amount of information is gained with the least expenditure of energy, at least on the part of the student. But this is a delusion. The knowledge thus gained is unreal and transient. It is "in at one ear, and out at the other." As we should naturally expect from the principle of self-activity, the ease of the method is apt to be inversely proportional to the efficiency of the instruction. In order therefore to train our students most efficiently in self-activity, we should use the maximum amount of the more difficult but more effective methods and the minimum of those easier but relatively inefficient.

This will perhaps be made clearer by a brief illustration from personal experience. To learn, for example, the normal histology of any given organ by means of a stained and mounted section, this should first be studied by *original observation.* The students observe the structure with naked eye, low power and high power of the microscope, and without previous description by teacher, book or laboratory outline. They record their observations by sketches and brief notes. The aid of the teacher at this stage should be restricted to questioning the individual students so as to recall related facts previously studied and prevent the student from going too far astray. At first, students are apt to be utterly helpless when thus thrown largely upon their own resources, but they soon develop surprising powers of observation. This "investigation" occupies the first part of the laboratory period. The teacher then informs the class regarding the section they have studied, and discusses briefly their mistakes of observation. He directs them in restudying the section, and in correcting their mistakes. The students now extend their knowledge by verifying the statements found in their text-books. Demonstrations are made to furnish additional data and elucidate the more difficult points. Drawings are finally made by the students, to fix the corrected impressions upon their minds. At a later class-conference, the students are led to review the facts learned, to correlate and interpret them and to reason out general conclusions or laws of structure. These laws they utilize and apply in the subsequent work. Brief written reviews are also frequently held. Occasional lectures by the teacher elucidate the more difficult phases, and indicate the relations of histology to physiology, pathology and clinical medicine. The results are satisfactory as shown by final examination, both written and practical, and by the extent to which the students are able to retain and utilize their knowledge in later work.

The foregoing method illustrates how students may be trained to self-activity in observation and reasoning, and to a certain extent in application. The application of the generalizations reached by observation plus reasoning, while essential in every subject, is especially characteristic of the clinical work. That the student should be self-active in his clinical work, that to acquire skill in the practical application of his previous knowledge he must "learn by doing," is universally recognized. It is therefore unnecessary to dwell upon this phase of the subject. It may be worth while, however, to remember that, above all, in the clinics, "the main business of the teacher is to render his services unnecessary" (Strayer).

To summarize the foregoing: it has been maintained that in medical education there is great need of more effective methods of teaching. Efficient teaching requires a clear view of the ultimate aim, which in medicine is to train efficient practitioners. To accomplish this aim, rational methods of teaching should develop in the student self-activity in observation, reasoning and action. While some may be unable to accept fully the ideas here presented, all will surely agree that great improvement would result if medical teachers would study more carefully their educational methods. The younger teachers who are so fortunately located could greatly improve their efficiency by taking work in the schools of education connected with the various uni-

versities. Those unable to do this should at least study the principles of pedagogy, which are available in numerous books. Although pedagogical literature deals chiefly with elementary, rather than advanced or professional education, it is nevertheless of great service, for the same fundamental principles extend throughout, from the kindergarten to the university. Among those books which may be recommended as helpful are the following: Spencer, "Essays on Education" (a recent edition, with introduction by ex-President Eliot, in the "Everyman's Library" series); James, "Talks to Teachers on Psychology," etc. (Holt); Charters, "Methods of Teaching Developed from a Functional Standpoint" (Row, Peterson & Co.); Bagley, "The Educative Process" (Macmillan); Thorndike, "The Principles of Teaching Based on Psychology" (Seiler). And in conclusion, permit me to suggest that a more thorough discussion of educational methods and principles in our association meetings, and also in the faculty meetings of our various medical schools, would result in greater efficiency in our teaching.

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SCIENTIFIC NOTES AND NEWS

PROFESSOR ABBOTT LAWRENCE ROTCH, founder and director of the Blue Hill Meteorological Observatory and professor of meteorology at Harvard University, died on April 7, aged fifty-one years.

DR. JOHN H. MUSSER, professor of clinical medicine in the University of Pennsylvania and one of the most eminent physicians of Philadelphia, died on April 3, in his fifty-seventh year.

THE second annual award of the Willard-Gibbs Medal, founded by Mr. William A. Converse, will be made by the Chicago Section of the American Chemical Society on May 17, to Professor Theodore W. Richards, of Harvard University. It may be remembered that the initial award of this medal was made last May to Professor Svante Arrhenius. Professor Richards has chosen for the subject of his address "Atomic Weights." An invitation is extended to all members of the American Chemical Society, who desire to be present on the occasion of this award.

SIR J. J. THOMSON has been elected a foreign member of the Naples Academy of Sciences.

THE clay model for a bust of Commander R. E. Peary has been executed by Mr. William Couper and is now on its way to Florence to be cut in Carrara marble. The bust is a gift to the American Museum of Natural History from Mrs. Morris K. Jesup and will take its place among the other marble busts in the niches in memorial hall.

THE Paris Geographical Society will present Dr. Charcot with its gold medal for the work achieved in South Polar exploration by the *Pourquoi Pas* expedition.

THE council of the New Zealand Institute, at its annual meeting held in Christchurch at the end of January, decided to award the Sir James Hector memorial medal and prize to Dr. L. Cockayne as the investigator, working in New Zealand, who has done most to advance botanical science.

THE Academy of Science, the medical faculty of the University of Havana and several other scientific societies and institutions have passed a joint resolution in which the names of Dr. Carlos J. Finlay and Dr. Aristides Agramonte are presented to the Nobel Prize Commission as candidates for the prize to be awarded in 1912. The resolution points out that Dr. Finlay was the first to claim that yellow fever is transmitted by the mosquito, while Dr. Agramonte is the sole survivor of the United States Army Board composed of Drs. Reed, Carroll, Lazear and himself, which demonstrated the correctness of this theory.

THE magazine *Good Housekeeping* announces that Dr. Harvey W. Wiley, formerly chief chemist of the United States Department of Agriculture, became contributing editor of that magazine on April 1. The magazine has established at Washington a "Bu-